NEW DEVELOPMENT IN CHEESE-MAKING PRACTICES

by

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INTRODUCTION

It is not known exactly when the first cheese was made, but according to Herrington (1948) cheese and butter were known since the time of Adam and Eve. They were old when writing was new.

From these early days it seems that cheese was considered as an important part of the food supply carried by the soldiers of the Mongol empire who ruled Asia and a large part of Europe in the thirteenth century, according to Eckles et al. (1951). They stated also that the people of Greece used cheese from 1000 to 450 B.C., and the Romans from 775 to 750 B.C.

Cheese-making in ancient times was entirely different from that of today. Peterson (1945) pointed out the first cheese made was probably the result of natural souring of milk. Modern cheese-making is based on scientific knowledge which has been discovered in this field since 1850. Before this date cheese was made in the family home because people at that time were dependent on their cows for milk and milk products.

According to Eckles et al. (1951) the cheese made in America during the Colonial time was about of the same varieties which the pioneers made in Europe before they came to this country. Certain sections of the United States became famous for special varieties because of the settlement of these sections by the European pioneers from different locations. Herkimer County, New York, became the home of the Cheddar cheese, and Green County,

Wisconsin, became the home of Swiss cheese.

Herrington (1948) states that in 1851 a man by the name of Jesses Williams started to make cheese from milk at home near Rome, New York.

Between 1860 and 1870 a large number of cheese factories were established according to Eckles et al. (1951). During this period about two-thirds of the cheese made in the United States was made in factories. The results of the scientific research and the formation of a large organization in the field of dairy industry were two of the important factors which influenced the growth of modern cheese factories.

Cheese as a food product has been regarded highly because of its nutritive value. Attention was given to the foods high in solids during the last World War because of the necessity of conserving shipping space.

Thoman (1925, p. 104) defined cheese as a solid or semi-solid protein food product made from milk. The nutritive value of cheese is based largely on its vitamin A content, its fat and protein content, its digestibility, and its ability to preserve the nutrients it contains over a long period of time.

More varieties of cheese are found on the American markets today than previously. As Eckles et al. (1951) reported, the varieties of cheese found on the American markets are American Cheddar, Colby, Cottage, Neufchatel, Roquefort, Swiss, Limburger, Camembert, Brick, and processed cheese. They also stated that France is famous for the Camembert and Roquefort. Switzerland is the leading country in Swiss cheese production. England makes

primarily Cheddar and Stillon varieties. Gorgonzala and the Parmeson varieties are common in Italy.

Eckles et al. (1951) said that New York was the leading state in cheese production at the beginning of the development of the cheese industry. Today Wisconsin is the chief manufacturing state. Illinois, Indiana, Ohio, Missouri, Michigan, Minnesota, Oregon, and Texas are also important in cheese production.

Herrington (1948) reported that about 50 per cent of the ripened cheese, Swiss, Limburger, and Munster, is made in Wisconsin. He also reported that the consumption of cheese in the United States has been increased from 3.9 pounds per capita in 1918 to 6.3 pounds per capita in 1942. American people use much less cheese than the European people because there is a supplement of milk constitutents from other sources such as meat for protein. The per capita consumption of cheese in the United States and other European countries is presented in Table 1.

Table 1. The prewar per capita consumption of cheese in selected countries.

Country	Pounds per year	Country	Pounds per year
Switzerland	17	Italy	9
Sweden	13	New Zealand	9
Germany	12	United Kingdom	9
France	12	United States	6

Source: From Milk Industry Foundation, 1940.

During World War II there was more demand for cheese than there was before, and most of the cheese was sold after a short ripening period, because there was a need for protein supplement when other protein sources were insufficient. This increase in demand was a factor in increasing the production of U.S. No. 1 cheese in this country. Lochry etal. (1951) reported that a program was conducted during this period in nine different states which required the improvement of the quality of U.S. No. 1 cheese. By the method recommended, the quality of U.S. No. 1 cheese was increased from 25 to 86 per cent during the introductory period, and from 96 to 100 per cent eight months after the introduction of the method.

THE MANUFACTURING PROCESS DEVELOPMENTS

Quality Milk and Quality Tests

When cheese was made on the farms, the cheese makers did not pay much attention to the quality of the milk from which the cheese was made. Probably the reason for that was they did not know the relationship which exists between the quality of cheese and the quality of milk from which it is made.

Sammis (1942, p. 86-90) said that to get the best quality cheese, the milk should go into the cheese vat in the same fresh, clean condition as when it comes from the udder of a normal healthy cow. Healthy cows and attendants, nutritive clean feed and pure water, feed free from weeds and materials that cause objectionable flavors and odors, cleanliness and good sanitary

operations, proper cooling, and frequent deliveries are the most important things to consider in producing a good quality milk.

Examination of the milk for flavor, odor, color, sediment and acid content is essential in checking the quality of milk and is practiced by most cheese makers today. Wilson (1940) stated that another quality milk test used to detect the quality of milk for cheese-making is the methylene blue test.

Clarifying the milk especially for Swiss cheese manufacturing is practiced today to promote proper eye formation and good quality product as Sammis (1942, p. 86-90) reported.

Mechanical cooling methods are in practice by most of the cheese manufacturers to keep the milk and the cheese at the proper temperature. Improvement for producing good quality milk used for cheese making did not stop at these developments, but is still continuing to help in producing the best quality cheese which the consumer desires.

Standardization of Milk for Cheese-Making

Standardizing the milk for cheese making is one of the newest developments. The main reason for this standardization is the variation in the fat and casein contents of milk from different animals. Herrington (1948) stated that cheese can be made from cow's milk, sheep's milk, goat's milk, camel's milk, and buffalo's milk. The percentage of fat and casein in the milk of these animals is different.

Sammis (1942, p. 86-90) defined standardization of milk for cheese-making as a method by which the cheese makers can produce

a cheese containing the desirable amount of fat and casein in dry matter. The legal standard for cheese requires that the cheese contain at least 50 per cent of fat in the dry matter. Sammis (1942, p. 86-90) also pointed out that since April 9, 1941, the U. S. Federal regulations permit the standardizing of milk for Cheddar cheese, Colby, and washed curd cheese. Also the state of Wisconsin today requires the standardization of milk for Cheddar cheese.

Pasteurization of Milk for Cheese-Making

Pasteurizing the milk for cheese-making is one of the most important developments in the field of cheese-making. According to Lochry et al. (1951) pasteurization of milk for cheese was first used in 1907. They also explained that commercial pasteurization in the cheese industry was practiced in New Zealand about 1912. In this country it was carried on a large scale around 1926 to 1929. Lochry et al. (1951) emphasized that the Federal law of the Food and Drug Administration requires that if the milk used for cheese-making is not pasteurized the cheese must be cured for at least 60 days at 35° F. to protect the public health against possible transmission of disease-producing microorganisms.

Wilson (1948) explained that pasteurization of milk at 143° F. by the holding method for 30 minutes or by the flash method at 160 to 165° F. for 15 seconds is necessary to improve the quality of cheese. The main purpose of pasteurizing the milk is to kill the majority of the undesirable microorganisms. Various tests have been applied to determine if the cheese was

made from properly pasteurized milk. According to Sanders and Sager (1946) the common phosphotase test used for checking the proper pasteurization of milk is also used for detecting the cheese or the milk used for cheese-making if it is properly pasteurized.

Starters and Their Functions

Starters in general are defined as a clean culture added to milk or milk products to produce desirable flavor. Not much was known about starters until about 1884. Hunziker (1940,p.324) stated some of the European bacteriologists found the advantage of adding starters for the proper souring of milk.

Van Slyke and Price (1949, p. 158-259) reported that the addition of a pure lactic acid culture to the milk used for cheese-making is necessary when it does not contain the necessary kind and amount of lactic acid bacteria. The purposes of adding lactic acid starter in cheese-making as given by Van Slyke and Price (1949, p. 158-259) are:

1. It makes possible the proper coagulation of the milk before the rennet is added.

2. It stops the growth of undesirable microorganisms in the milk.

3. It is the chief agent that makes possible the control of texture of the cheese.

Use of Color

Colorless cheese is still prepared by most of the European people. When cheese was first made there was no color added.

Kent (1937) reported that the coloring of butter and cheese is based on the color of the milk from which they are made. The cheese-makers always watch the public demand for the artificial coloring of cheese. The cheese exported to England has to be either very brightly colored or not at all.

Kent (1937) also explained that the coloring materials used for coloring the cheese is called Annatto which is obtained from the seeds of the Annatto plants which are largely cultivated in India and America. He also gives the methods of application and the amount needed.

Use of Rennet Extract

The ability of the rennet to coagulate the milk was noticed long ago. Van Slyke and Price (1949, p. 158-259) stated that the effect of rennet as the coagulation of milk is due to the following two enzymes found in the rennet extract:

1. Rennin enzyme is probably responsible for the coagulation of casein.

2. Pepsin is believed to be partly responsible for the hydrolysis of cheese protein during ripening. The most noticeable advances made in this field were the measuring of the strength of the rennet extract, and the proper conditions for the rennet to function.

Time-schedule Method for Making Cheese

Cheese-making during the early days was not based on a definite time required for each step to control the entire process of cheese-making. Lochry et al. (1951) reported that the Bureau of Dairy Industry in 1948 developed a method called the time-schedule method which is used by many cheese factories with excellent results. The use of this method is possible because pasteurization produces milk of uniform quality. The first practice in using this method was experimentally to produce the correct acidity at each stage in the process of cheese-making.

Lochry et al. (1951) also explained that following the temperatures indicated in the time-schedule method is necessary to have a normal acidity and to free the cheese from acid and bitter flavors. It also aids in having a cheese of smooth texture, free from mechanical defects, and of a high keeping quality.

The time-schedule method is either long or short according to Lochry et al. (1951). The difference between the two is that the longer schedule requires a total making time of 8 hours instead of 7 hours from the time of adding the starter until the time of dressing the cheese.

Using the Clock Systematizes Cheese-Making

The use of the time-schedule method by having a clock over each vat to control the time required for each proces is important. Lochry et al. (1951) explained the operation of this new development by having the operator follow the time-schedule

and watch a wall clock showing the actual time which has to be recorded when each step begins. The hand of the clock should be moved to the beginning of the next step when the time for the preceding step is over. By using this method the cheese makers can avoid errors, and save time and labor.

NEW MECHANICAL DEVELOPMENTS

Mechanical improvement made during the last 10 years was one of the most important factors influencing the growth of the cheese industry. Modern machinery has made it possible to increase greatly the capacity of plants for handling milk or milk products.

Eckles et al. (1951) reported that mechanical refrigerators which were introduced to the dairy industry after 1890 are widely used by cheese makers.

Rapid expansion of the cheese factories had encouraged many scientists to develop various new equipment needed for cheese-making. Cheese vats, curd knives, curd rake, curd mill, cheese hoops, cheese bandages, cheese press, paraffin tanks, and equipments for quality test have been improved. Park (1951) said that during the World War II years there was much demand for cheese which forced the cheese makers to operate on an emergency basis. A design was made to speed up the process of loading and unloading of the milk cans received at the platform of the cheese plants.

Park (1951) also reported that today cheese factories are using two to twelve-vats filled with steel jackets. The capacity

of these vats is between 1000 to 1250 gallons and the vats are covered with sanitary tops. Most of these vats are supplied with dish pans to speed up the drainage process, and they contain mechanical agitators fitted directly to the vat frame. Some of the latest vat designs are the round end type which avoids the collection of the cheese curd in the corners and are easily cleaned.

Mechanical agitators started to replace the wooden type agitators since 1947 to take the hard work out of the cheese makers. Also Park (1951) mentioned the installation of a machine called cheese trammel to the cheese factories to carry the entire process which removes the curd from the whey and dries it.

Whey disposal also is one of the new developments according to Park (1951). Various kinds made of stainless-steel placed at the end of the cheese vat are now used.

The hydrolic pressing machine used to remove the cheese at the end of the day, and the use of the oil-fired steam generators as a source of power unit which replaced the use of boilers are also some of the mechanical developments according to Park (1951).

RIPENING OF CHEESE

Ripening is the curing time required after the cheese has been made and before it is ready for consumption.

Van Slyke and Price (1949, p. 158-259) stated that some cheese is ready to eat as soon as the curd making process is finished.

Others take a few days for ripening, and still others which require months or years to develop the proper quality. The purposes of the ripening process are:

1. To develop a special physical characteristic of flavor
2. To develop a definite color
3. To develop a definite odor
4. To develop a desirable body and texture

During the ripening process the following changes occur:

1. Decomposition of the protein of the milk
2. Hydrolysis of the fat
3. Production of volatile fatty acids
4. Fermentation of the lactose
5. Evaporation of moisture
6. Changes in acidity
7. Change in oxidation reduction potential
8. Production of gas

The biological agents responsible for these changes are:

1. Bacteria
2. Yeasts
3. Molds
4. Enzymes
5. Combination of them

Wilster (1945) stated that cheese should be weighed before it is put in the curing room. The storage room should be kept at a temperature of 50-60° F. and the humidity should be 70-75 per cent for the purpose of keeping the cheese from drying. During recent years the coating of cheese with specially manufactured wax has become common in the cheese factories.

Sometimes a mixture of one-half wax and one-half paraffin is used. After the ripening process is completed the cheese should be stored at 30-32° F.

Wilson (1940) stated that cheese packed in valve-vented cans can be cured at temperatures as high as 60° F. with no shrinkage or labor involved. The 12 ounce can is a convenient size for consumers. The cans should be wrapped and packed into cellophane or parchment paper.

Wilster (1945, p. 1-3) also said that packages of 1/2 pound, 1 pound, 2 pound, and 5 pounds cheese may become common in the refrigerated display cases in food stored.

YIELD AND COMPOSITION OF CHEESE

Yield of cheese made from a given amount of milk is varied due to the composition and manufacturing process.

Eckles et al. (1948) said that the yield of cheese of the hard types varies from 8 to 14 pounds per 100 pounds of milk used. The yield of soft cheese is greater than that of the hard types. The yield of soft cheese ranges from 12 to 16 pounds per 100 pounds of milk.

Wilster (1945) stated that the variation in the yield of cheese is due to:

1. Amount of casein lost in the vat
2. Amount of fat lost in the whey
3. Pasteurization of the milk
4. Salt content of the cheese
5. Moisture content of the cheese

Quantitative analysis of cheese showed that different variations have a different composition.

Eckles et al. (1948) stated that the composition of cheese depends on the varieties of cheese.

Most of the variation is with the fat and the water.

Table 2 shows the approximate composition of some of the most common cheese varieties according to Eckles et al. (1948).

CLASSIFICATION OF CHEESE AND VALUE OF IMPORTANT VARIETIES

Classification of cheese is a process by which a variety can be recognized from the other varieties displayed on the markets.

Peterson (1945, p. 8-12) stated that classification of cheeses on the market is based on:

1. The hardness of the finished cheese
2. The characteristics of the milk or the product from which the cheese is made

On the basis of hardness:

Soft cheese
- a. Unripened--as cottage and cream cheese
- b. Ripened by bacteria as limburger
- c. Ripened by molds--as camembert

Semi-hard cheese
- a. Ripened by bacteria--as brick cheese
- b. Ripened by molds--as roquefort cheese
- c. Cheese made from whey as primost cheese

Hard cheese
- a. Without gas holes--as cheddar cheese
- b. With gas holes--as Swiss cheese

Processed or reworked cheese

Table 2. The approximate composition of some of the most common cheeses.

Variety of cheese	Fat per cent	Protein per cent	Lactose and ash per cent	Water per cent
Cottage cheese	0.40 - 1.90	12.70 - 21.00	0.20 - 1.20	71.40 - 79.90
Neufchatel	23.00 - 28.00	18.00 - 21.00	0.50 - 1.25	50.00 - 55.00
Swiss (American)	30.00 - 34.00	26.00 - 30.00	3.00 - 5.00	30.00 - 34.00
Cheddar (green)	30.00 - 36.79	20.80 - 26.11	3.12 - 7.02	32.69 - 43.89
Roquefort	31.50 - 33.53	19.14 - 23.06	5.18 - 5.81	37.49 - 40.10
Brick	28.34 - 33.77	20.03 - 23.29	1.68 - 4.20	39.61 - 45.26

On basis of the product used:

Rennet or sweet milk cheese
  a. Soft cheese
  b. Ripened by bacteria
  c. Ripened by molds

Hard cheese
  a. With gas holes
  b. Without gas holes

Sour milk cheese

Whey cheese

Processed cheese

The hard types of cheese are produced in large amounts in the United States.

Hammer (1948) stated that many varieties of cheese are found on the markets, but the differences between two or several varieties are insignificant. He also classified the cheese into hard, semi-hard, and soft cheese according to the moisture content of the finished product. He also explained that hard cheeses are mostly bacteria ripened, semi-hard cheeses are primarily bacterial or mold ripened, while soft cheeses are mostly bacterial or mold ripened or unripened.

ROMANO TYPE GRATING CHEESE

In World War II most of grating cheese was imported from Europe. According to Mattick et al. (1951) the United States imported an average of 50,000,000 pounds every year. There were some factories producing such kinds of cheese but not enough.

Shortly after the war started the supply from foreign countries, principally Italy, was cut down. This led most of

the cheese makers to start making this cheese on a large scale here in the United States. The cheese they are making now was the typical flavor, body, and texture as that of the grating Romano type.

One advanced move was made in this country by producing a Romano type grating cheese ripened with a short curing period. The long curing foreign process requires about two years, as Mattick (1951) stated.

He also reported that a cheese of similar flavor and similar body can be obtained when a pasteurized, homogenized cream is standardized to two per cent with skim milk and streptococcus lactis culture mixed with a liquid rennet used for coagulation.

Standards of identity for most of the common varieties of cheese made in the United States have been promulgated by the Federal Food and Drug Administration (January) 1949. The type of cheese for which standards have been established includes:

Cheddar cheese	Gruyere cheese
Washed curd cheese	Brick cheese
Colby cheese	Muenster cheese
Cream cheese	Edam cheese
Neufchatel cheese	Goudo cheese
Cottage cheese	Blue cheese
Granular cheese	Gorgonzola cheese
Swiss cheese	Roquefort cheese
Limburger cheese	Hard cheese
Monterey cheese	Semisoft cheese
Provolone cheese	Soft ripened cheese

Caciocavallo cheese	Spiced cheese
Parmesan cheese	Hard grating cheese
Romano cheese	High moisture jack cheese
Asiago cheese	Gammelost cheese
Cooked cheese	Others

PACKAGING AND GRADING OF CHEESE

About 40 years ago there were only a few varieties of cheese packages on the market. At that time most cheese was sold by cutting the amount the consumer needed by the grocer and wrapped the pieces with paper as our meat departments in grocery stores do today.

Garry (1950) reported the second step was packing the cheese in 1/2 pound, 1 pound, 2 pound, and 5 pound packages. Further development was by using coated cellophane wrappers to hold the cheese in better condition and for a longer period of time. Cream cheese packed in pails brought new uses to the cheese field. He also mentioned in his speech the idea of cutting Swiss cheese into quarters, or eighths, or sandwich cuts and wrapped with cellophane paper.

Brick cheese today is dipped in a wax before it is wrapped in cellophane paper. Limburger cheese and Camenbert cheese are wrapped in a heavy coated pail for protection.

Gary (1950) also reported that Blue cheese today is sold in various sizes from three-quarters of an ounce to one pound sizes.

He also stated that plastic containers are an excellent carrier for cheese. He reported that the recent advance made in

the cheese industry is sliced cheese. By this new development it helps the housewife to have a uniformed sliced cheese well packed. It also helped in bringing new customers as the slicing of cheese from one-half or two pound packages is available. He also said that the development of the Christmas cheese boxes which are sold by mail mostly is new in the field of cheese.

Grading of cheese is a very important step for evaluating the market price of different kinds of cheese produced. Judging the cheese first to see its definite characteristics is necessary.

Grading is used after studying the characteristics of the cheese product to put the products in different groups based on their characteristics. Van Slyke and Price (1949, p. 158-259) reported that scoring cards are also used for classification of cheese in terms of points or numbers. They also reported that the United States Department of Agriculture (1943) developed a standard that contained different requirements for grading cheese of different ages. Such standards are helpful to produce better cheese of better quality which will get a higher price on the markets.

Van Slyke and Price (1949, p. 158-259) also stated that the standards made by the Wisconsin Department of Agriculture in 1941 for Cheddar cheese are accepted and used by most of the cheese industries. Suitable flavor, good body, acceptable color, uniformity, and moisture content are the most important characteristics to look for in cheese grading.

Wisconsin State Brand, Wisconsin Junior, and undergrade are the grades used by Wisconsin Department of Agriculture. U. S. Grade AA, or U. S. Fancy; U. S. Grade A or U. S. No. 1; U. S. Grade B or U. S. Grade No. 2; U. S. Grade C or U. S. undergrade, and no grade, are the grades announced by the U. S. Department of Agriculture according to Van Slyke and Price (1949, p. 158-259). They also explained all the requirements for each of these grades.

Van Slyke and Price (1949, p. 158-259) also reported that using scoring cards for grading cheese is not commercially used. Its value is mostly for education and research purposes. This system was first started in 1916 for judging contests. The American Dairy Science Association in 1922 developed an official score card which is used now in judging different kinds of cheese and for training people to grade the product.

MARKETING TRENDS OF THE CHEESE INDUSTRY

Quality of the product is one of the important factors which influences the marketing price. Cheese marketing is wholly a matter of quality, because quality does control the consumption of cheese.

Foster (1949) stated that the United States now produces about 40 per cent of all the cheese produced in the world. It produced about 1,100,000,000 pounds of cheese in 1948, and at that time there were about 1,800 cheese factories.

Bendixen (1948) reported that the cheese production was increased 55 per cent, and civilian per capita consumption to

about 17 per cent from 1938 to 1946.

Gaummitz (1946) explained that during World War II the production of cheese has increased from 700 millions pounds per year to 1,100 millions pounds. The government used about 400 millions pounds for the army.

Table 3 compiled by Foster (1949) shows the percentages of some varieties produced in 1947.

Table 3. Relative importance of different varieties of cheese produced in the United States, 1947.

Kind of cheese	Per cent
American Cheddar cheese	79.5
Swiss cheese	6.1
Cream and Neufchatel cheese	5.3
Italian varieties	3.2
Brick cheese and Muenster	2.2
Blue molds	0.9
Limburger	0.7
All others	2.1

Source: Foster (1949)

Foster (1949) also explained that the production of cheese in 1948 was different from that of 1947. Less Cheddar cheese was produced in 1948 than in 1947 because of high prices which discouraged the consumption of cheese in the American homes. Production of 1949 was about 29 per cent higher than that of 1948, and the amount of Cheddar cheese produced in 1947 was around 1,177,669,000 pounds.

Marquardt (1949) reported that the amount of cheese produced during the past five years exceeded a billion pounds a year, and the cheese industries now are using about 9 per cent of the nation's milk supply available for human consumption. He also explained that about 85 per cent of the hard cheese is made from milk diverted from the fluid market. In 1946 about 8 per cent of the milk was rejected as unclean milk.

People of different ages have a different desire for certain varieties of cheese. Table 4 compiled by Foster (1949) shows the varieties or the kinds of cheese preferred by the people in 1947.

Table 4. Kinds of cheese preferred by the people in 1947.

Kinds of cheese	No. of responses	Per cent	No. of responses	Per cent
Natural cheese	377	40.6	164	17.7
Processed cheese	366	39.3	408	43.9
Spread cheese	41	4.4	113	12.2
Cream cheese	74	8.0	128	13.8
Home made cheese	37	4.0	56	6.0
Not stated	34	3.7	59	6.4
Total	928	100.00	928	100.0

Source: Foster (1949)

Children prefer processed cheese, spread, and cream cheese. Another survey was conducted to find which flavor people prefer. The majority shows they like the mild flavor cheese, then comes the sharp flavor. As the people advance in age they prefer the sharp flavor cheese.

Cost of production of cheese today is much higher than it was before. Irvine (1948) stated that more wages are paid now to produce one pound of cheese than was paid in 1920. The labor costs of the dairy industry have increased approximately 80 per cent since 1939. The best way to reduce this high cost is by enlarging the size of the factories because large factories are more efficient than the small factories.

The improvements made by the chain and independent retailers in their dairy product display is one of the factors influencing the selling of cheese. Padgett (1940) reported that most of the cheese makers found that the answer for selling their cheese is by radio which was started in Denver, Colorado.

A feature article in the National Butter and Cheese Journal, December, 1947, explained that canned cheese is a new item on the domestic markets. It became popular after the reputation gained by canned cheese factories. The size of the cans ranges from one pound to seven and three-quarters ounce. It does not require any refrigeration because the cheese is kept in sealed cans.

Improvement in the field of cheese industry for the last few years was tremendous, due to the market demand and supply. People all over the world still look for the best kinds of cheese they prefer to use.

According to Gaumnitz (1951) the cheese industry today is using about 12 billion pounds of milk per year which is about 10 per cent of the milk produced on the farm yearly. He explained that the amount of milk used by the cheese industry has been increased since 1929. It would be expected from this increase in

the amount of milk used that the amount of cheese made would be increased also. Table 5 by Gaumnitz (1951) gives the volume of the various varieties of cheese produced. The amount of cheese produced by each plant has been increased. In 1939 about 2,370 pounds of American cheese was produced by 2,284 plants while in 1949 about 556,000 pounds was produced by 1,682 plants.

Another increase in production was found by the amount exported during the war year. Gaumnitz (1951) stated that during 1950 exports amounted to about 47,000,000 pounds and in 1951 will exceed nearly to 70,000,000 pounds.

As far as the importation of cheese from other countries is concerned a decrease was noticed for the last few years due to economical, political, and social reasons. Gaumnitz (1951) reported that the act of 1950, effective July 31, 1951, introduced by the Defense production has decreased the amount imported to this country. It says that no imports of cheese or butter shall be admitted to the United States until after June 30, 1952. He concluded that the trends in the cheese industry during the last 20 years were mostly noticed in standardization, introduction of rindless cheese, and particularly, the consumer packages, increase in production and consumption, mechanization, by-product utilization for other purposes, and decrease in the importation.

Table 5. Cheese quantities manufactured in the United States - 1931 to date.

Period	Whole milk	Part milk	Swiss	Brick and Muenster	Limburger	Cream	Blue mold	All Italian	All others	Total
	Quantities in 1000 pounds									
1931	374,698	3,108	28,234	35,484	8,608	33,637	---	3,493	4,851	491,963
1935	468,999	6,554	42,622	37,522	9,535	38,971	---	10,628	5,890	620,731
1940	602,790	3,890	48,659	34,328	8,198	51,185	---	25,002	11,440	785,490
1945	875,089	1,098	50,065	14,756	8,777	66,912	9,828	64,628	25,627	1,116,772
1950	882,850	(1)	100,180	32,265	7,910	63,250	7,650	53,680	29,690	1,171,825
Average 1945-1949	879,706	2,692	65,816	23,170	8,123	65,500	10,056	55,360	30,454	1,140,888

Compiled from reports of the U. S. Department of Agriculture.

(1) Included in all other.

QUALITY CONTROL OF CHEESE

It is hard to say what is the most important factors controlling quality. It seems that everything connected with the cheese-making has an influence on the quality of the product. The latest developments in the field of cheese-making were mostly concerned with the quality control. Quality as Sheehy (1948) explained is more important than the amount of cheese produced. He said that cheese made from a homogenized milk has a high quality under tropical and subtropical conditions. Arbuckle (1939) stated that the manufacturing and ripening of cheese are both physical and chemical changes that depend on different kinds of factors. These factors as given by Arbuckle (1939) are:

1. Milk fat: it influences the yield, color, and the body of the cheese.

Sheuring and Tucky (1947) stated that pasteurization reduces the hydrolysis of the fat in the Cheddar cheese. The addition of an organic acid accelerated the hydrolysis of cheese fat as active acid but it produces undesirable effects in the flavor of cheese. Citric acid gives a sharp flavor.

Sanders (1947) stated that cheese containing natural or added fat can be dehydrated in a direct process without liquification or oxidation of the contained fat or loss of volatile flavor. This can be done by drying of the thinly particles through a current of air at a room temperature to reduce the moisture content. Further drying at the same temperature for one hour will reduce the moisture content from about 8 to 12 per cent. Final dehydration

takes place at a temperature of at least 145° F. which reduces the moisture content to about 3 per cent. He stated that the advantages of this method are: saving time, space for storage, and weight.

Hlynka and Hood (1917) reported that the addition of copper has no effect on the lipase inhibitors in Cheddar cheese due to the strength reducing potential of the cheese.

Kasikowsky and Dahlberg (1946) reported that a short and rapid method was discovered to determine the volatile fatty acid in cheese. The operation of this method required a fine grained sulfuric acid cheese mixture with a low pH which drives out the CO_2 and distills in the present of $MgSO_4$. Distillates were titrated with N/20 NaOH. Using phenolphthalein as indicator the sum of the titration of the water distillated and the alcohol rinse represent the total volatile acidity of the cheese.

2. Casein: it affects the action of rennin, control of moisture, and flavor development by breaking down the protein. Dahlberg and Kasikowsky (1947) reported that there is a direct relationship between flavor intensity of cheese and its soluble protein and its value.

3. Moisture content: the water acts as a dispersion medium for the other constituents of milk cheese.

Wilster (1945, p. 1-3) reported that for the cheese factories the dry aluminum dishes with covers on them are used to determine the moisture content of the cheese. Ten grams of cheese is put in the dish and heated to 220-230° F. in the oven for 24 hours. It can be completed in 4-6 hours if 40-50 pounds of pressure are

are used at 290° F. The dish should be cool to about room temperature and weight to nearest 0.1 per cent.

4. The milk sugar: it influences the amount of lactic acid produced by bacteria.

Katznelson and Hood (1949) reported that penicillin today is used to control the amount of lactic acid produced by the started organisms. This practice is mostly used in the manufacturing of Cheedar cheese. It was studied by incubating a mixture or a single strain starter culture into the pasteurized milk. Complete inhibition of acid production was obtained with 100 units per 100 millimeters of milk. Partial inhibition was evident with 0.5-5.0 units in both the single and the mixed starters. They said that milk obtained from cows during the three day penicillin treatment, and for one day thereafter, can be used for other purposes beside cheese-making. The loss of this milk may be avoided by the addition of penicillinase. He also reported a complete inhibition by penicillin in skim milk ranging from 0.2 to 0.4 units per millimeter.

5. Milk salts: the coagulation of the curd is affected by the rennin culture, and the rennet action is influenced by the kinds and amount of salts found in the milk.

Wilster (1945, p. 1-3) reported the amount of salts is determined by using silver nitrate solution. The number of cc of $AgNO_3$ used minus the titration value divided by the weight of the sample equals the amount of sodium chloride in the sample of cheese.

Hood (1946) reported that the salted curd method is used to find the extraneous matter in most kinds of cheese.

6. Pasteurization. The undesirable microorganisms in the milk used for cheese-making are destroyed by pasteurization.

Slater and Halvorson (1947) reported that the majority of lactobacilli found in Cheddar cheese made from raw milk can be killed by pasteurization. The fermentation characteristic of the lactobacilli found in Cheddar cheese had little correlation with their heat resistance. The destruction of lactobacilli may accelerate the ripening of Cheddar cheese made from pasteurized milk. This will produce more favorable growing temperature for the reduced number of S. lactis bacteria that survive pasteurization.

7. Kinds of organisms present: Parmelee and Nelson (1949) reported that the addition of culture of Candida lipolytica to milk for cheese-making improves the flavor score and increases the total volatile acidity of the cheese.

Dahlberg (1948) reported that a bacterial culture planted in cheese during the manufacturing process will cause a rapid development of a superior Cheddar flavor. This culture is known as D-K, which means Dahlberg and Kasikowsky. The advantage of this culture is reducing the time required for the flavor development. At 60° F. this culture will form flavor within 2 1/2 months, while without this culture it requires 4 1/2 months to develop the same flavor. He reported that these bacteria are found in the digestive tract, and in curd cheese.

Alford and Frazier (1950) reported that micrococcus freudenreichii caused an increase rate of flavor development during the early months of the ripening of Cheddar cheese. The addition of a large mass of micrococci to cheese made from pasteurized milk

when it was ground at the age of 2-3 weeks resulted in a rapid development of flavor during curing at 5 to 7° C.

8. Treating the milk with foreign materials:

Nelson and Baker (1949) reported that the addition of amino acid to Cheddar cheese made from pasteurized milk has no effect upon the flavor development under certain conditions.

Calbert and Price (1949) reported that diacetyl is an important element in the flavor of many kinds of food. The diacetyl content of cheese ranges from 0.016 milligram to 0.335 milligram per 100 grams of cheese. The best is to have a cheese contain from 0.05 milligram per 100 grams of cheese.

Parpia et al. (1950) state that American cheese of a superior flavor can be produced with the aid of chemical agents obtained from filbert nuts. This chemical is known as proteolytic enzymes.

Peters and Nelson (1948) reported that the addition of cell-free lipase obtained from Mycatorula lipelytica to homogenized milk used in the manufacture of blue cheese greatly improves the desirable characteristics of the ripened cheese due to the production of ketones and more fatty acids.

Blanchard (1949) reported that a defect was found in some kinds of cheese due to small crystals formed in the cheese. The researchers found that these crystals are calcium tartrates used in cheese processing. They are produced as a result of the reaction of the tartrate with the calcium of the milk.

Arbuckle (1939) reported that treating the cheese milk with 1-5 per cent of curd cheese tends to give a desirable flavor. Adding 3/4 pounds of cane sugar to 100 pounds of curd just before

salting will improve the quality of cheese.

Marquardt (1949) reported that the addition of 0.5 per cent gum with the salt will prevent leakage in cream cheese.

Tucky (1939) reported that the latest development in application of modern science to cheese industries is to see the flavor of cheese as a fuzzy picture through the diffraction photographs. By using X-rays one can see a shadow of masses of atoms forming proteins in cheese. It is based on showing the amino acids produced by breaking down the protein during the ripening process.

9. Ripening temperature and aging: the maximum flavor developed faster at a temperature of 60° F. than at 45° F.

Baker (1946) has reported a process designed to reduce the necessity of aging the cheese. This is done by cooking the curd with water at a steam pressure of 10-15 pounds and a temperature of 239° F.

Ewel (1945) reported that ultra-violet ray lamps may be used for aging cheese to reduce dehydration in the aging process. A relative humidity of 80 per cent is required. To speed the ripening process, the temperature is raised to an average of 45-50° F. which is about 15° F. higher than the temperature in the aging rooms of unprotected cheese by ultra-violet lamps. It also reduces the shrinkage of the cheese. The ozone produced by these lamps will stop mold growth. He stated that by the aid of the ultra-violet light one can obtain the benefit of high humidity and freedom from bacterial contamination.

SUMMARY

Cheese is one of the oldest foods of mankind. There is a possibility that cheese was prepared from milk by accident when milk was held in a container made of the stomach of sheep. It was known in Greece 2,500 years ago.

France is the home of fancy cheese, but cheese eating habit is found in all corners of the earth.

Cheese is very important in the human diet.

1. It is a good source of protein.
2. It is a good source of calcium.
3. It is a concentrated form of energy.
4. It is a perfect source of vitamins.
5. It has a high digestable value.
6. It can be used for many purposes at home.

It deserves a place in every home as a household stable because of its usefulness in economical meal planning. One-fourth pound of American cheese furnishes more than enough energy for one day for adults.

It is generally agreed that quality in cheese is very important in order to give a maximum satisfaction for the cheese consumers.

When cheese was first made, the climate, the local conditions, and the habit of the people were mostly considered.

Today cheese-making is an art as well as a science.

Inspecting the milk, clarification, homogenization, pasteurization, and standardization are very important steps which should

be considered by the cheese makers.

Starter is a common name for a culture of a desirable organism used in making cheese or other dairy products.

All the varieties of cheese are produced by following the essential steps in cheese-making. The different varieties are produced by altering certain essential conditions of manufacture. Cheese manufacturing consists of two well-defined stages, the curd making, and the ripening stage.

The general technical control of cheese-making is based on:

1. Control of properties of milk
2. Control of curd formation
3. Control of changes in the curd
4. Control of the removal of whey
5. Control of the ripening process

The yield of cheese from 100 pounds of milk is various due to the variation in the milk constituents and in the methods of manufacturing.

There are many varieties of cheese on the market but about 18 of them are the most common varieties. Cheddar cheese, cottage cheese, Swiss cheese, and limburger cheese are some of the leading varieties produced in the largest amounts.

Cheese is a concentrated form of the milk constituents, principally; fat, casein, and insoluble salts, together with water. There are some soluble salts as lactose and albumin found in small portions.

High quality cheese of a uniform texture and flavor are more and more in demand by the people of the earth. People may learn

to appreciate the nutritive value of the cheese, but this alone will not help the industry. What will help is for the cheese industries to produce the kind of cheese people like at a price the consumer can afford to pay.

Today is the day at which science is improving everything; the improvement of science of the following items:

1. Improvement of dairy cattle
2. Development of scientific feeding and management
3. Development of science of nutrition
4. Development of science of bacteriology
5. Development of science of chemistry
6. Development of agriculture education
7. Education and promotional organization
8. Development of marketing organizations

Today there are still many problems facing the cheese industries which should be solved by scientific methods. Some of these factors are related to the chemical composition of the milk. Others are related to the type of microorganisms and to the methods used in handling the manufacturing process.

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